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ABSTRACT

This study was designed to: (1) determine the extent of the availability of physics laboratories in Kenya's secondary schools; (2) assess the quality of the laboratories in terms of how well they are equipped, how much it costs to equip them, and how often materials are purchased; (3) assess the quantity of laboratory work done in terms of time spent doing practical work; (4) examine the quality of investigative laboratory work, considering to what extent objectives for practical work have been met and whether the work done in the laboratory is individual-, group- or teacher-centered; and (5) assess the effect of laboratories on the performance at O-level examinations. Data were obtained from school personnel using questionnaires (included in appendices) and interviews, laboratory observations using Flanders interaction analysis and the Laboratory Programmes Variables Inventory, and the Kenya Certificate Examination. Results are provided in separate sections for each of the five areas examined. Recommendations based on these results include ensuring the availability of a physics laboratory for all schools regardless of the physics course taught, setting a minimum quantity of laboratory equipment in all schools, and providing support materials when changes are made in the physics syllabi. (JN)

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THE ROLE OF THE
LABORATORY IN THE
TEACHING OF 'O' LEVEL
PHYSICS, KENYA.

AGC Project

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THE ROLE OF THE LABORATORY IN THE TEACHING OF ORDINARY LEVEL

PHYSICS IN KENYA SECONDARY SCHOOLS

BY

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Submitted to the Department of Educational Administration, Planning
and Curriculum Development in partial fulfilment of the requirements
for the Post Graduate Diploma in Curriculum Development.

UNIVERSITY OF NAIROBI

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JOYCE N. MUSOKO

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CHAPTER ONE

"Take interest I implore you in those sacred dwellings which one designates by the expressive term laboratories. Demand that they be adorned. These are the temples of the future, temples of well being and happiness. There it is that humanity grows greater, stronger, better."- Louis Pasteur.

A: INTRODUCTION:

Physics is an experimental science in which laboratory work is essential in maximising learning. Many scientists and science teachers agree that students learn better and more from observation and doing than from mere lectures. The availability of a science laboratory in a school will enable the students to acquire skills in experimentation and making observations.

The laboratory, in a broad sense, is considered as an environment which provides the scientist, young or old, with conditions necessary for the study of phenomena of interest to him. The laboratory as such is, therefore, the central theme of any science course. It is a place where evidence is obtained and used for the development of a Science Course. It is a place where evidence is obtained and used for the development of science concepts. It is also a place where special skills and aptitudes are learned in the case of the young scientist.

The nature of Physics as a science requires that the laboratory be seen as both a classroom and as a place for practical work. Infact all science teaching should take place in the laboratory. Other scholars have even extended the definition of the laboratory to include any setting where learning takes place, including the moon and the nature garden. For the purpose of schools the term laboratory will refer to the conventional use of the word as a place equipped for experimental study in science.

Schools offering Physics in Kenya are required by regulation to ensure that there is a laboratory for teaching the subject.

It is, however, evident that there are not enough laboratories for the school populations in Kenya. The few laboratories that are there, are poorly equipped and sometimes are not appropriately utilized by the teachers and learners.

Currently, in Kenya, the number of schools offering Physics is limited by among other factors, the availability of laboratories. The number of students enrolled for Physics in those schools is limited by the number of laboratories and also by the mere fallacy that Physics is a 'difficult' subject to study.

It is the purpose of this study to investigate the availability, quality and effects of Physics Laboratories in Kenyan secondary schools. Information regarding the quality of laboratories and laboratory work will be collected using a sample of schools located in Nairobi. Additional information regarding the provision of other teaching resources and the quality of teachers will also be used to ascertain the quality of Physics teaching in the sample schools.

Findings from the study will be used to recommend optimum use of the laboratory with a view to improving the teaching of Physics by providing an adequate number of well equipped laboratories. At the same time the findings will be used to devise a system of ensuring that the conditions under which the subject is learned are as uniform as possible in all schools in the country. These findings will be of benefit to the curriculum planner, the administrators and the examining body as well as to the teacher in the classroom.

B: BACKGROUND:

In Kenya, three Physics courses are offered from Form I to Form IV in the secondary schools.

These courses are;

1. Pure Physics
2. Physical Science Physics, which is a combination of Physics and Chemistry;
3. General Science Physics, which is a combination of Physics, Chemistry and Biology.

The combined subjects that is Physical Science, Physics and General Science Physics are usually taught with very little integration and normally by more than one teacher. Most of the Government Schools offer one or both of the first two options and a majority of the private schools offer General Science.

As stated earlier all schools offering Physics must at least have a laboratory or a science room¹. This regulation eliminates schools who would otherwise wish to offer Physics as a subject. The Ministry of Higher Education has recommended that all Physics teaching/learning should take place in the laboratory except where there are not enough laboratories in a given school. It is, however, stressed that the double lessons should at any rate be taken in the laboratory. The major argument behind this requirement is that teaching in the laboratory will facilitate the integration of practical work with class teaching. It is, therefore, imperative that every science subject should have its own laboratory.

In many Kenyan schools one laboratory serves as a science room for Physics, Chemistry, and Biology. In a number of cases there may be two laboratories; one for Physics and Chemistry and the other for Biology. This state of affairs tends to limit the amount of practical work that is done by the students.

Practical work, however, plays an important role in the following aspects;¹

- (a) developing various manipulative skills;

¹ Source: Curriculum guide for secondary schools

- (b) arousing and maintaining interest and an attitude of curiosity;
- (c) encouraging careful observation and accurate recording;
- (d) showing what is meant by scientific experimentation, proper use of controls and presentation of data;
- (e) verifying scientific facts and principles already learned/taught.

In Kenya attempts have been made to inculcate a practical approach to the teaching of Physics as seen in the introduction of courses such as SSP Physics (School Science Project)¹. It is, however, noted that failure to implement the SSP courses in all schools throughout the republic can be attributed to the lack of funds and resources. Not all schools were sufficiently equipped to offer SSP courses and especially Physics which was the most expensive of the SSP courses. In appreciation of the practical approach of the SSP courses, the new O-level Physics syllabus is a merger of the SSP course and the traditional Physics syllabus. The present problem is whether with new syllabi for both Pure Physics and Physical Science, the schools have laboratories that are well equipped and staffed and in sufficient numbers to effect the learning of Physics.

C: THE PROBLEM:

In Kenya there are 2,000 secondary schools with 96,000 pupils. Out of these about 6,000 pupils offer Pure Physics², 25,000 pupils offer Physical Science and 65,000 pupils offer General Science Physics at O-level.

¹The SSP courses were adopted from the Nuffield courses. These courses were offered in Physics, Chemistry and Biology.

²Physics as a single subject.

TABLE 1: THE NUMBER OF PUPILS OFFERING PHYSICS COURSES IN KENYA

Pure Physics	6,000
Physical Science	25,000
General Science	65,000
Total.	96,000

In most schools Physics is taught in Forms I and II. At the beginning of Form II students elect to proceed with either Pure Physics or Physical Science Physics except in some Private and Harambee Secondary Schools. As a matter of fact the figures given in table 1 above, are for candidates that are actually presented for Physics examinations conducted by the Kenya National Examinations Council. Examinations in Kenya tend to be highly selective. Performance in the Kenya National Examinations Council (KNEC) examinations is used for selection for higher education as well as for job recruitment.

As mentioned earlier a given school may offer both Pure Physics and Physical Science to different streams or classes in the school. Table 1, shows the number of pupils who study the different types of Physics programmes. General Science is offered in Private Schools which cannot administer practical examinations. Pure Physics and Physical Science Physics have practical examinations at the end of form IV. This is besides the theory examinations offered in the same courses. It is, however, true that both the practical and the theory examinations in Physics rely to a large extent on the amount and type of practical work done in schools. It is, therefore, important that laboratory lessons should prepare candidates for both the practical and theory examinations. A lot of the questions in the theory papers assume

a basic background of practical work and experimental techniques¹. This fact is usually not realized by many teachers.

The practical examinations alone account for 20% of the marks awarded in the final examination to qualify for the award of the ordinary Kenya Certificate of Education (KCE) by the Kenya National Examination Council (KNEC). The breakdown of these marks for Physical Science Physics practical examination,² in terms of actual marks is given in table 2 below. The table also shows the mean scores obtained in the various categories by candidates in the 1980 examination.

TABLE 2: ALLOCATION OF MARKS FOR PRACTICAL EXAMINATION INCLUDING MEAN SCORES FOR 1980

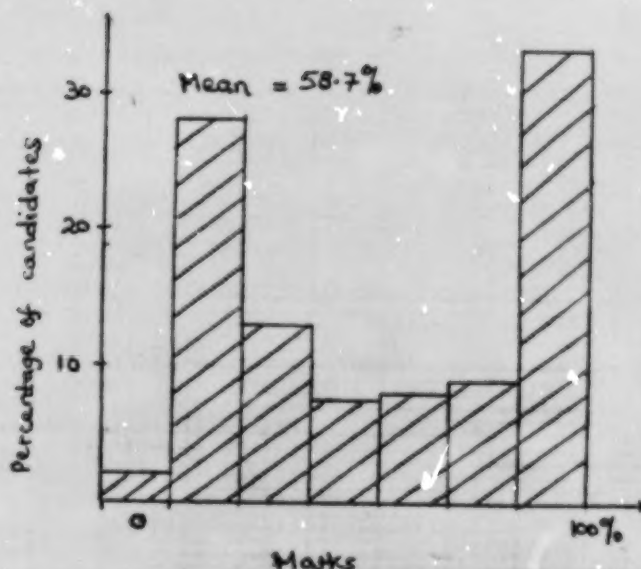
CATEGORY	MARKS ALLOCATED OUT OF 20	MEAN MARKS %
(i) . taking readings	3	58.7
(ii) displaying readings	7	65.1
(iii) - (IV) interpreting results	10	40.9

The mean marks in the above table do not however tell the full story. The chart below shows a truer picture of performance on the most elementary of the practical skills, that is the skill of taking readings.

¹KNEC: Kenya Certificate of Education (KCE)
Physics Newsletter, 1981.

²Physical Science Physics, Paper 3 (a) 1980.

FIGURE 1: DISTRIBUTION OF % OF MARKS FOR TAKING READINGS¹

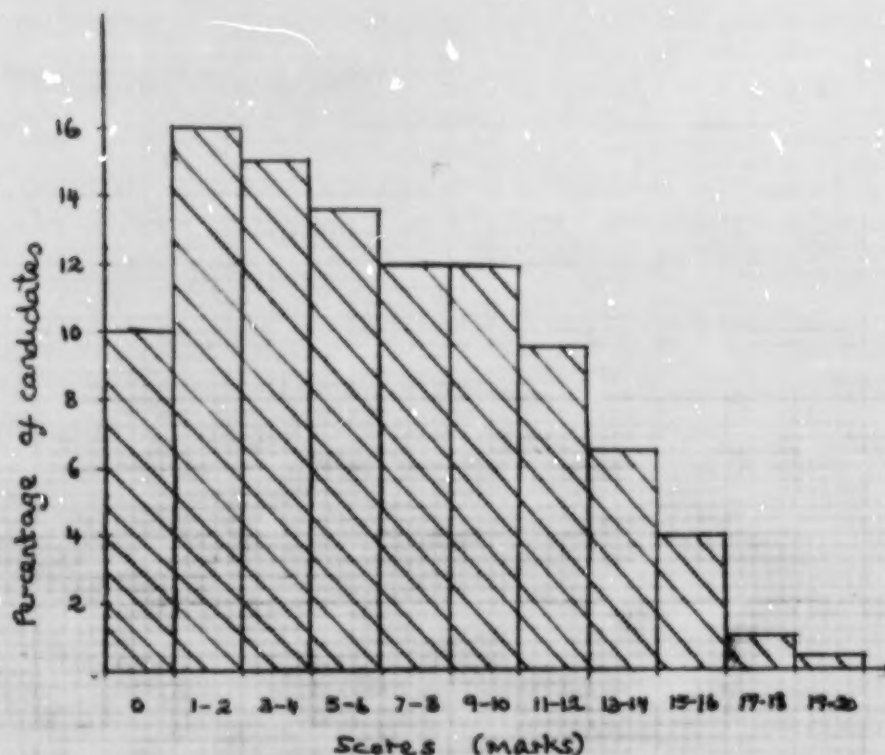


It can be seen from the chart that about 30% of the candidates scored virtually nothing and yet about 33.5% scored all the marks allocated for taking readings. The chart shows a sharp distinction between candidates that CAN and those that CANNOT take readings. Since this was obvious in many schools one possible explanation was that some pupils hadn't got a chance to master simple skills of experimentation. One possible reason was probably due to lack of sufficient apparatus for class experiments or the use of very large groups.

It is even more disheartening to note that in 1979 in the same paper, 10% of the candidates scored zero and that the modal mark was between 1 and 2 out of 20 marks. The rest of the marks distribution is shown in the chart below, for the same year.

¹ KNEC: KCE Physics Newsletter

FIGURE 2: DISTRIBUTION OF SCORES FOR PRACTICAL EXAMINATION (1979)²



From the above chart 10% of the candidates who sat the practical paper scored zero. The chart further shows that a large number of students scored between 1 and 2 marks. This indicates an obvious lack of basic practical skills. It is probably due to the fact that the practical aspects were actually omitted in the teaching. Admittedly the 1979 Physical Science Physics practical was less familiar and, therefore, difficult to the candidates. The results, however, point to the quality of laboratory work that is done in our schools. As compared to the 1980 examination the percentage of students scoring zero in 1980 was less than 1% and the modal mark was between 11 and 12 out of 20 marks. The 1980 practical incidentally had an experiment that was more familiar to the pupils and the apparatus were cheap compared to the 1979 experiment. The mean scores out of 20 in the two years changed from 6.4 in 1979 to 10.1 in 1980.

² KNEC: KCE Physics Newsletter, 1981.

The above facts go to show the importance that laboratory work has on the performance of candidates in their examinations. It is, therefore, important and necessary that for pupils to perform satisfactorily in both the theory and practical examinations, they must get ample opportunity to learn the skills and concepts in the laboratory. This is especially important since selection for further education and employment is based on their performance in these examinations.

The conditions of the Physics laboratories in Kenyan schools is far from being satisfactory. In the first place there aren't enough laboratories for every school. As indicated earlier there have been and still are some schools which have had no option but to teach only arts subjects because they don't have laboratories. Some schools infact offer General Science without laboratory facilities. In a number of schools only one laboratory is available for all the science subjects offered. In such cases both the pupils and the teachers do not get sufficient time to work in the laboratory.

Many schools which actually have laboratories lack funds to equip and maintain them. Insufficient time is devoted to laboratory work in many cases. Many laboratories serve large populations of pupils and they are not properly organized. Many old schools have the rigid type of laboratories with fixed benches that allow very little flexibility to the organization by the teacher. Besides all these problems, there is a general shortage of adequately trained teachers and other laboratory support personnel.

Laboratory equipment of standard type is very expensive and difficult to maintain. Local production of low-cost equipment has met with little success because the component parts have to be imported.

Notable efforts have been made by the School Equipment Production Unit (SEPU) to produce science kits in Biology, Chemistry and Physics. Even then the price of the kits ranges from Kshs.450/- for the Biology kit to Kshs.875/- for the Physics kit (see below for prices). Many of the schools can afford at the most one or two such kits per subject. This means that students will not be able to work with the apparatus on their own. Teachers then resort to either demonstration experiments or to theory lessons instead of practical lessons. How effective are these substitute methods of teaching as opposed to practical work in the laboratory? It is not difficult to assess, since Physics has been branded as a difficult subject.

TABLE 3:

PPICES OF SCIENCE KITS FROM SEPU

KIT	PRICE PER KIT IN KENYA SHILLINGS
Biology Kit	450.00
Chemistry Kit	615.00
Physics Kit	875.00

D: PURPOSE OF THE STUDY

The purpose of the study is to obtain quantitative data on the conditions of Physics laboratories in Kenya. Information will also be sought on the use of the laboratories in teaching. Some of the questions that will be asked will be whether the laboratories do in fact facilitate the acquisition of those attributes of practical work that have already been defined. If not, what recommendations can we make as precedents for improvement?

In order to be able to propose any improvements, we need to establish to what extent the factors, of availability, funds, crowding and time available among others, do actually affect the teaching of Physics in the laboratory.

It is important for the Physics curriculum developers to know the type of teaching/learning conditions that exist for which he prepares curricular materials. As mentioned earlier the new syllabi in O-level Pure Physics and Physical Science Physics have merged both the traditional and School Science Project (SSP) syllabi. Are our laboratories enough, sufficiently equipped and staffed to effectively implement these new syllabi? It is also true that one practical paper in Pure Physics and Physical Science Physics is set for each of these Physics courses in the O-level Examinations by the Kenya National Examination Council. Performance in these practical examinations shows clearly that a large proportion of Kenya schools do not prepare their pupils adequately for these examinations. This could be due to factors outlined earlier. Is it fair to set practical examinations requiring the handling of apparatus or use of concepts which the pupils have not had an exposure to?

In a similar study carried out in Italy¹ and presented at the 1978 Oxford Conference on "the Role of the Laboratory in Physics education" the above mentioned factors were shown to be significantly responsible for

the insufficient performance in Physics. Based on the findings from the Italian¹ study it is intended that the objectives of this study will be to;

- (1) establish the extent of the availability of Physics laboratories in secondary schools;
- (2) assess the quality of the laboratories in terms of;
 - (a) how well they are equipped,
 - (b) how much it costs to equip a laboratory, and
 - (c) how often are the materials purchased.
- (3) assess the quantity of laboratory work done in the laboratories in terms of actual time, in the year, spent in the laboratory doing practical work;
- (4) assess the quality of laboratory work done by investigation
 - (a) to what extent objectives for practical work have been met, and,
 - (b) whether the work done in the laboratory is individual or group or teacher centre ;
- (5) assess the effect of the laboratories on performance at the O-level examinations.

¹ COPPI P., Cortini G., Fano P., and Bernadini S.,
Some data on the use of Physics Laboratories
in Italian schools (Paper presented at the Oxford
Conference on - The Role of the Laboratory in
Physics Education - 1978)

CHAPTER TWO

METHODOLOGY

A: SAMPLE SELECTION:

The main part of the study will be conducted in Nairobi.

A total of 21 schools will be involved in this study.

The study will seek information from the following persons and groups of persons.

1. The Senior Inspector of Schools for Physics.
2. The Provincial Education Officer for Nairobi Province
3. Headmasters/Mistresses of sample schools in Nairobi
4. Teachers of Physics in the sample schools.

1. The Inspector of schools will provide documented information on the number of schools in Kenya offering Physics, to confirm information in table 1. Information of the staffing of these schools and the standard requirements for the construction and equipping of Physics laboratories in the country will also be given by the Inspector.

2. The Provincial Education Officer will be asked to provide information on the types of secondary schools in Nairobi offering Physics.

The selection of the schools will more or less be according to the following categories set below.

TABLE 4: CATEGORIES OF SCHOOLS IN NAIROBI

Category	Description	Number of schools
A	Schools with A-level as well as O-level Physics (Pure or Physical Science)	7
B	Schools with <u>only</u> O-level Physics (Pure with/or without Physical Science)	5
C	Schools with only Physical Science Physics.	4
D	Schools with General Science Physics	5
TOTAL 21	TOTAL	21

Out of these schools the following numbers will be selected from each category.

TABLE 5: NUMBER OF SCHOOLS SELECTED IN EACH CATEGORY

Category	No. of Schools Selected
A	7
B	5
C	4
D	5
TOTAL	21

The Head teachers of the selected schools will be asked to supply information on the following aspects;

- . the category of the school as shown above
 - . whether the school has 0, 1, or 2 Physics laboratories
 - . whether the laboratories are well equipped, or not
 - . laboratory expenditure in the last two to three years, and
 - . the presence of laboratory support staff such as laboratory assistants/technicians
4. Teachers of Physics in the selected schools will be asked to supply information on the following aspects.
- . the quality of laboratories they work in
 - . the quality of laboratory work done in the laboratories and whether it actually does meet the objectives set for practical work in the "curriculum guide for Secondary Schools"
 - . the supply of laboratory materials
 - . the quantity of laboratory work done in terms of the amount of time devoted to actual practical work

The number of teachers involved in the sample will depend on the number of schools. It is hoped that all Physics teachers in the selected schools will be involved in the study.

B:

DATA COLLECTION INSTRUMENTS

1. Interview Schedules A and B:*

Schedule A: This schedule will be used for collecting background information from the Chief Inspector of schools for Physics.

Schedule B: This will provide background information from the Provincial Education Officer for Nairobi.

2. Questionnaires C and D

Questionnaire C: This questionnaire will be addressed to head teachers

Questionnaire D: This questionnaire will be addressed to Physics teachers in the selected schools.

3. Observation Schedule E:

The observation schedule will be used by the investigator for observing at least one laboratory session in each of the selected schools. This schedule will be based on the Laboratory Programmes Variables Inventory (LPVI)** and on Flanders Interaction Analysis.

* . See appendices A, B, C, D, E.

** . See appendix F.

C:

ADMINISTRATION OF INSTRUMENTS

Personal interviews will be conducted with the Inspector of schools and the Provincial Education Officer since both Officers are stationed in Nairobi.

The questionnaires will, however, be delivered to the teachers well in advance by the investigator and collected after a suitable interval as suits the headmaster and the Physics teacher. All this should be done in the first one and a half months of the study.

The initial visit will also be used to arrange for a suitable time when the investigator can observe some of the lessons in the schools. If possible this observation schedule will be used in the Form 3 classes in the schools. The significance of this is that in Form 3 the students have elected to study Physics for their form IV examinations, and, therefore, have a genuine motivation for the subject.

CHAPTER THREE

DATA ANALYSIS

A: ANALYSIS METHODS

Nairobi Province has a total of 75 secondary schools and the sample of 21 schools selected is just slightly less than one third of the total number of secondary schools. Among the schools selected some fall under the category of National Schools which select their students nationally from all over the republic and many of them are either fully boarding or half boarding half day. Similarly there is a large number of privately run and managed secondary schools.

Of more significance in selection of the sample was the grading of the schools whether private or government. The grading of the school indicates the academic and physical development of the school¹. Grade A schools, therefore, offer a well balanced and organized curriculum in a full-time secondary school. Amenities in grade A schools will include provision of textbooks, a library and provision for the teaching of practical subjects such as science and technical subject. The other grades of schools B and C fall short of the standards of staff and facilities available in grade A schools.

Grade D schools are those schools that have not been graded but are fully registered by the Ministry. Usually grading to higher grade is after inspection by the Inspectorate Section of the Ministry of Higher Education.

The selected sample of schools can be summarised in the following types;

¹:Ministry of Education:

A manual for heads of Secondary Schools in Kenya - 1979

TABLE 6

TYPES OF THE SELECTED SCHOOLS

TYPE OF SCHOOLS	GRADE					TOTAL
	A	B	C	D	Other	
Government	8	2	0	0	1	11
Private	2	7	1	-	-	10
TOTAL	10	9	1	0	1	21

Of the selected schools the types of Physics courses of offered in the schools could be summed in table 7 below;

TABLE 7:

THE PHYSICS COURSES OFFERED IN THE SCHOOLS

TYPE OF SCHOOLS	A-LEVEL PHYSICS	PURE PHYSICS	PHYSICAL SC.	GEN SC.
Government	4	5	3	1
Private	2	4	2	4
TOTAL	6	9	5	5

It can be seen from table 6 that almost an equal number of Government and private schools was selected. Of all the schools 9 were boys' schools, 6 girls' schools and 6 mixed schools. As mentioned earlier the majority of the schools are either day or mixed day and boarding.

In table 7 the totals indicate the number of schools offering a given Physics course but do not show schools offering more than one Physics course.

A total of 21 copies of Appendix C, questionnaire for Head teachers of the sample schools, were sent out. 18 of the questionnaires were returned about 85.7% of the total.

45 copies of Appendix D, questionnaire for Physics teachers, were sent out to teachers in the 21 schools. 35 ^{copies} ~~pieces~~ were duly filled and returned, about 77.8% of those sent out. From the number of questionnaires sent out it can be seen that some schools had more than one teacher filling in the questionnaires. For purposes of analysis and justifiably so, each teacher was treated independently because they do not teach the same classes in their schools. In the few cases where identical information was given by two teachers from the same school then they were treated as one source. The main reason for doing this was that given the same facilities there are no two teachers that would use them in exact^{ly} the same way.

Appendices C and D were analysed on the basis of the returned questionnaires. In cases of the item by item analysis means and percentages were computed from the actual number of responses made. This is because in a few cases some respondents did not respond to all the items.

The observation schedule, Appendix E, was used in 17 of the 21 schools. The other schools either did not have any observable lessons or could not alter the schedule to fit in any laboratory lessons. The tallying procedure of 20 tallies per minute was adhered to, but analysis was broken into the particular Physics courses observed whether Physical Science or Pure Physics.

Appendix A, the interview schedule with the Inspector for Physics was used in a personal interview. Information from this interview has been incorporated in various sections of this report.

Information from the Provincial Education Office, has also been used ⁱⁿ various sections of this report, especially in compiling tables 6 and 13.

B: ANALYSIS OF QUESTIONNAIRES

(i) ANALYSIS OF APPENDIX C, QUESTIONNAIRE TO HEAD TEACHERS

A larger number of the government schools in the sample offer A-Level Physics than the Private schools. These schools that offer A-level Physics have a slight advantage over the other schools especially in terms of apparatus, although at the same time they are slightly disadvantaged in having larger numbers of students to be ^{be} cared for. Government schools also have a larger number of students offering O-level Physics than the private schools. A majority of the private schools offer General Science.

TABLE 8: STUDENT POPULATIONS PER PHYSICS COURSE

	A-LEVEL PHYSICS	PURE PHYSICS & PHYSICAL SCIENCE	GENERAL SCIENCE
Government	265	3660	132
Private	52	1263	1692
TOTAL	317	4923	1824

Many government schools have characteristically large number of streams per class. The size of these classes is on the average about 40 pupils per class. Private schools tend to have a slightly smaller average for class sizes. The average number of classes per school is higher for government schools than for private schools as shown in the table below.

TABLE 9: AVERAGE NUMBER OF CLASSES PER SCHOOL

	AVERAGE	LOWEST	HIGHEST
Government	16.7	4	26
Private	11.9	8	24

The average number of streams per class is given in table 10 below:

TABLE 10: AVERAGE NO. OF STREAMS IN THE SCHOOLS

	AVERAGE	LOWEST	HIGHEST
Government	3.3	1	6
Private	2.7	2	6

From the selected schools the mean school population was computed separately for government and private schools.

Table 11 shows these mean populations, the lowest and the highest school population.

TABLE 11: THE MEAN SCHOOL POPULATIONS

	TOTAL NO.	MEAN/SCHOOL	LOWEST/SCHOOL	HIGHEST/SCHOOL
Government	5594	621.6	132	960
Private	3638	426.4	260	1080

It can also be seen that 40.7% of the pupils in the sample schools are in private schools and that although the government mean population per school is higher, the highest single school enrolment is in a private school.

TEACHER QUALIFICATIONS

The proportion of non-graduate to graduate teachers for Physics in government schools is 11:10 and in some schools it is as high as 3:1 while in other it is as low as 0:3. In private schools, however, this ratio is 8:9, mainly due to the large number of Indian graduates teaching in private schools. It is, however, worth noting that 62½% of the non-graduate teachers in private schools are untrained A-level as compared to less than

10% of the same in government schools. About 5% of the total number of teachers in the schools have post graduate qualifications.

AVAILABILITY OF LABORATORIES

About 50% of the government schools have two Physics Laboratories. Generally the laboratories are such that one is for A-level Physics and the other for O-level Physics. Needless to say, but this is especially true of the former colonial European and Asian schools. Most of the other government schools have one laboratory being shared between two to three science subjects.

25% of the private schools have a separate O-level Physics laboratory and about 12-13% have 1 laboratory for both O- and A-level Physics. 38% have only one laboratory for all the three science subjects, noting that they teach General Science. Among the private schools a small proportion 12-13% use an old classroom as a laboratory.

Where laboratories exist in any form they have water electricity, gas and storage and many heads of secondary schools agree that their laboratories are fairly well equipped.

THE POSSIBLE IMPACT OF AVAILABILITY OF LABORATORIES

The school week has forty lessons and any one laboratory can facilitate the same number of lessons per week. By comparing the laboratory lessons provided by the number of laboratories and the number of laboratory lessons required by the Physics classes, we are in a position to assess whether the laboratory provides adequate time or not. The number of laboratory lessons required is computed by assuming that;

- (i) all the nine A-level lessons are taught in the laboratory where A-level classes exist.
- (ii) that all Physics teaching should be done in the laboratory
- (iii) that O-Level Pure Physics has a minimum of four lessons per week and Physical Science Physics has three lessons per week while General Science Physics has also three lessons per week.

Table 12 below is computed by adding up the total number of lessons provided by the available laboratories, and in cases where the laboratory is shared between two subjects then half the time is allocated to Physics. The total required time is in turn computed using all the classes that offer Physics including Forms I and II.

TABLE 12: A COMPARISON OF AVAILABLE LABORATORY TIME AND THE REQUIRED
IN GOVERNMENT AND PRIVATE SCHOOLS

(a) GOVERNMENT SCHOOLS

	LABORATORY TIME	REQUIRED TIME	NOTES/COMMENTS
1	80	64	All teaching can be done in the laboratory. Extra time available especially for the higher classes and individual work.
2	80	74	
3	80	74	
4	100	72	
5	40	35	Very little extra time in this case but all teaching in the laboratory
6	20	24	Substantial shortfall. Possibility of cutting down on junior time
7	20	24	
8	53	55	
9	0	8 - 12	No possibility of laboratory classes.

(b) PRIVATE SCHOOLS

	LABORATORY TIME	REQUIRED TIME	NOTES/COMMENTS
1	40	24	All teaching done in the laboratory
2	40	16	
3	40	21	
4	20	20	Hardly enough time to even fit in the actual teaching time. This shows a substantial shortfall in the laboratory time available
5	40	50	
6	13	16-24	
7	20	30	
8	13	48-72	
9	0	14-21	

Most government schools have enough laboratory time available to do most of their teaching in the laboratory. It will be seen from table 12(a) however, that where the time just fits the laboratory teaching load this means that no time is available for individual student experimentation. Many private schools have one laboratory or less than one laboratory for Physics. In many schools that teach general science one laboratory is used for all the three sciences that is Physics, Chemistry and Biology. Even then these same schools usually have very many classes and the one laboratory is hardly adequate for one subject (see Nos. 6 and 8 in table 12(b)). It is encouraging to note that a third of the private schools especially community based schools have more than sufficient laboratory time for laboratory work (see Nos. 1-3 in table 12(b)).

As mentioned earlier where the laboratories are available they generally have water, electricity, gas and store-rooms.

94.4% of the laboratories have water and electricity, 88.9% have gas supplies while 72.2% have storage and also agree that their laboratories are well equipped.

BUYING OF APPARATUS

64.3% of the schools put their apparatus expenditure over the last two to three years at over Kshs.3,000.00. 7.1% put at about Kshs.3,000 14.3% at less than Kshs.3,000 00. A further 14.3% are not sure about the expenditure. (cf. prices of Science kits).

50% of the schools do their apparatus shopping near examination time. These are schools that present candidates for the practical examinations. One wonders whether such purchases ever benefit the candidates at all. 43% of the schools do their shopping as the need arises and only a mere 35% do their shopping at the beginning of the year. Shopping at the beginning of the year gives pupils time to work with the apparatus. A few schools, however, buy both at the beginning of the year and as the need arises.

PERFORMANCE IN THE KENYA CERTIFICATE OF EDUCATION

The performance in the Kenya Certificate of Education was computed by finding the mean of the candidates from the sample schools who passed with

credit and above in the different Physics Courses. These means were in turn compared to the overall performance in the whole of Nairobi Province as given in table 13 below. The table is based on the 1982 examination.*

TABLE 13: PERFORMANCE IN THE KENYA CERTIFICATE OF EDUCATION

COURSE	MEAN OF THOSE PASSING WITH CREDIT AND ABOVE	
	IN NAIROBI(%)	ON SAMPLE(%)
Pure Physics	42.7	43.0
Physical Science Physics	26.3	44.0
General Science	5.1	3.4

It can be seen from table 13 above that of all the candidates in Nairobi who sat say the Pure Physics paper in 1982 only 42.7% obtained credit passes and above. It is more disheartening to see the figures of 26.3% and 5.1% for the Physical Science Physics and General Science papers. This means that these papers are very poorly done at O-level. The performance in the Pure Physics examination is rather expected since only schools with sufficient facilities are allowed to enter students for this paper. It is also known that in schools where both Physics pure and Physical Science Physics are offered, Pure Physics is usually offered to the brighter students and Physical Science to the less bright students.

FACTORS THAT CONTRIBUTE TO THE PERFORMANCE IN PHYSICS EXAMINATION

SELECTION:

Where the students selected for Physics are capable and sufficiently motivated the performance is usually good. This is as opposed to students who are weak, with a poor attitude and believe that Physics is difficult. Some of these students tend to also have a poor maths background. This argument is usually used to justify streaming of classes especially at the end of form II.

* By courtesy of the Provincial Inspector of Schools for Nairobi.

STAFFING

Well trained teachers, sufficiently keen in teaching will motivate their students. It is also evident that the mobility of Physics teachers is fairly high and as such there is a lack of continuity in the teaching. This lack of continuity in teachers demoralizes students and they lose interest. In many cases when a teacher is transferred there is no immediate replacement.

FACILITIES:

Inadequate practicals is a significant feature in a number of schools (ref. table 12(a)) and in a number of schools the laboratories are not sufficiently equipped to allow the desirable number of practicals.

Time is one facility that day schools are in dire need of. The majority of Nairobi Schools are either full day or half day half boarding and it is not possible to arrange extra work for say after school hours. It is also evident that there is hardly time for prep work during the day.

SUPPORT PERSONNEL

Where laboratories exist, many schools are hard put to employ even a laboratory assistant. Many of the laboratories have an over-worked laboratory assistant and very few have a qualified laboratory technician.

(ii) ANALYSIS OF THE QUESTIONNAIRE TO PHYSICS TEACHERS (APPENDIX D)

BACKGROUND

Of the 35 teachers in the sample 28.6% hold BSc general degrees with no Education Training. 14.3% are untrained teachers, ex-A-level and these are found mainly in private schools.

8.6% hold SI certificates and 17.1% have BEd (Science) qualifications with a similar percentage having an assorted range of qualifications from Diploma in Education to MSc.

Of the total number of teachers who actually teach Physics there are those for whom Physics is not a major subject. This of course has little significance as far as untrained A-level teachers are concerned

because of the lack of any special training. The table below shows a distribution of the teachers and whether Physics is their major or their second subject.

TABLE 14 ANALYSIS OF WHETHER PHYSICS IS A MAJOR OR A SECOND SUBJECT

Course taught	Major Subject	second Subject	Total No. of Teachers
A-level Physics	6	1	7
Pure Physics	10	7	17
Physical Science Phy.	8	6	14
General Science	4	3*	7

Thus out of the 14 teachers who teach Physical Science Physics, 8 have Physics as their major teaching subject about 57% of the total number of Physical Science Physics teachers.

Of the total number of teachers in the sample about 58.6% have maths as the other subject either as a second subject or as a major subject. The whole range of other subjects taught by the Physics teachers ranges from maths to Kiswahili as shown in the table below.

TABLE 15: RANGE OF OTHER SUBJECTS TAUGHT BY TEACHERS IN THE SAMPLE SCHOOLS

	NUMBER OF TEACHERS
Chemistry	9
Maths	20½
Industrial Education	1½
Biology	3
Kiswahili	1
Total	35

The average teaching loading per teacher is about 26.0 lessons/week while the teaching experience ranges from zero to thirty-two years with a mean at eight years.

AVAILABILITY OF LABORATORIES TO TEACHERS

Of the total sample, 34.3% the teachers have access to 30.4% of the available laboratories for O-level only, where 37.1% of the teachers have 37% of the laboratories for both O- and A-level Physics. 17.4% of the laboratories are shared between Physics and Chemistry, whereas 15.2% are for all the three Science subjects Physics Chemistry and Biology. It is disheartening to note that 8.6% of the teachers have to teach Physics without laboratories.

TABLE 16: ANALYSIS OF THE TYPE OF LABORATORIES AVAILABLE

TYPE OF LABS	NUMBER OF LABS	% NUMBER OF TEACHERS
O-level only	14	34.3
O and A-level	17	37.1
Physics & Chemistry/Biology	8	22.9
Physics, Chemistry & Biology	7	20.0
No labs	3*	8.6

With the available number of laboratories shown in table ¹⁶, above 14.3% of the teachers report a laboratory use of upto 3 lessons per week. The majority of the teachers, that is 37.1% use the laboratory upto 2 lessons per week. A meagre 11.4% use their laboratories for all the Physics teaching.

TABLE 17: LABORATORY USE IN TERMS OF LESSONS PER WEEK AND ITS OCCURANCE IN THE SAMPLE

MODE OF USE	% OF THE SAMPLE
3 lessons per week	14.3
2 lessons per week	37.1
2 lessons every alternate week	14.3
1 lesson per week	8.6
More than 3 lessons per week	14.3
No lessons in laboratory	8.6
Other	2.9

During the laboratory use it was observed that different teachers use varying amounts of time in the laboratory on say class experiments as compared to demonstration experiments. From the total sample the mean percentages of time spent on the different activities per year were computed and set in table 18 below.

TABLE 18: MEAN TIME SPENT ON DIFFERENT ACTIVITIES IN THE LABORATORY

ACTIVITY	PERCENTAGE OF TIME SPENT PER YEAR
Class experiments	33.5
Demonstration experiments	19.3
Lectures/theory	45.2
Other (tests, quizzes etc)	1.9
TOTAL	99.9%

This shows an unfavourable amount of time devoted to lectures/theory lessons and only about one third of the total time devoted to class experiments.

LABORATORY PROVISIONS:

Although analysis of appendix C showed that most of the respondents showed that their laboratories were well equipped, the teachers were asked to rate the adequacy of some of the provisions that are usually taken for granted. Table 19 below show these provisions and the percentage of the teachers who ranked them accordingly.

TABLE 19: THE RANKING OF LABORATORY PROVISIONS

PROVISION	ADEQUATE	NOT ADEQUATE	NOT AVAILABLE
Benches	82.9%	8.6%	8.6%
Stools/Chairs	80.0%	11.4%	8.6%
*Apparatus	51.4%	40.0%	8.6%
Water	88.6%	2.9%	8.6%
Electricity	85.7%	0	14.3%
Storage	85.7%	5.7%	8.6%

Many teachers report that their laboratories do not have adequate apparatus as shown by the 40% who responded as such in the above table. There is, however, a small but still significant 8.6% who responded not available to any of the laboratory provisions. In many cases these were teachers from the same schools who responded to zero laboratory for Physics.

ORGANIZATION OF CLASS EXPERIMENTS

The average number of pupils per Physics class was found to be 36 pupils. From the respondents the class experiment groups were according to the following percentages as shown in table 20 below.

TABLE 20: CLASS EXPERIMENT GROUPS

GROUPS	PERCENTAGE OF RESPONDENTS
1 - 2 Pupils	17.9
2 - 3 Pupils	28.6
3 - 4 Pupils	32.1
5 - 6 Pupils	17.9
upto 10 pupils	3.6

Many of the respondents give the ideal group size of 3-4 pupils per group, but still a significant 21.5% give group sizes of 5 -10 pupils. This means that in such large groups the pupils find it difficult to do any individual work. The respondents were asked to rank the extent to which aims for laboratory work are achieved as shown in Appendix D, Item 15. The ranks were as follows:

- 1 - Not at all
- 2 - to a small extent
- 3 - to a satisfactory extent
- 4 - to a large extent
- 5 - to a very large extent

Table 15 below shows a summary of the total number who ranked each aim and the distribution of the ranking by all the respondents for each. The corresponding figures 3 (a) to (k) give histogram representations

of the ranks given per aim.

TABLE 21: ITEMS AND THE NUMBER OF RESPONDENTS RANKING THEM

ITEM RANKING	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
1	0	0	0	0	1	0	1	1	1	1	0
2	0	1	4	2	6	9	12	3	5	6	4
3	23	14	12	13	11	13	11	10	13	10	13
4	3	15	8	13	10	5	5	15	11	13	7
5	3	3	5	2	3	1	1	4	2	2	6

SUMMARY

Aim (a) - to teach basic practical skills.

Many respondents gave rank 3 to this aim showing that they agree that their Physics laboratory lessons teach the basic practical skills to a satisfactory extent. The rest of the respondents give the last two ranks of 4 and 5. The absence of ranks 1 and 2 as responses is notable showing that however limited the amount of practical at least some skills are learnt.

Aim (b) - to familiarize students with standard apparatus and measurements techniques-

The modal rank for this aim is between 3 and 4 showing that achievement of this aim ranges from satisfactory to a large extent.

Aim (c) - to train students in making observations.

The modal rank is again three but with a wider distribution into ranks 4 and 5. The extent to which this is achieved, therefore, ranges from a very small extent to a very large extent depending on the teacher pupils and laboratory conditions.

Aim (d) - to train students in making deductions from measurements and interpretations of experimental data.

This aim has a bimodal distribution with equal responses for ranks 3 and 4. On the whole all respondents agree that this aim is achieved in varying degrees.

Aim (e) - to use experimental data to solve specific problems -

The mode is at rank 3 but with an almost similar number at rank 4 and a significant number at 2. This^{is} probably due to the uncertainty with which the respondents integrate their problem solving and experimental work.

Aim (f) - to train students in writing reports on experiments -

This aim apparently scores a rather modest mode at rank 3 with more of rank 2 than rank 4. This probably augments the observation made in observation schedules that the experiments tend to be cookbook work where all the instructions are given including the write-up.

Aim (g) - to train students in simple aspects of experimental design -

This aim scores a mode at rank 2 closely followed by rank 3, which is a true picture of what actually happens. As mentioned earlier all the experimental instructions are normally given at the beginning of the laboratory lesson and any designs or alterations to the design of the experiment are done by the teacher and not the students.

Aim (h) - to arouse and maintain student interest in the subject -

This aim shows a mode at rank 4 with more than half the respondents ranking it as being achieved to a large and very large extent. This is particularly significant in laboratory work.

Aim (i) - to show the use of practicals as a process of discovery.

The mode for this aim is at rank 3 - closely followed by rank 4. This should, however, have a mode at the higher rank. A possible explanation for the modest 3 is probably as given earlier that the idea of discovery is negated by the cookbook approach of most practical lessons.

Aim (j) - to verify scientific facts -

A mode at rank 4 probably reflects the inclination of most of practicals carried out in Physics lessons. They are always geared towards

towards verifying some law or principle in one concept or another. It is interesting to note that even then, quite a large number of the respondents do not think so as shown by the frequencies in rank 1 and 2.

Aim (k) - to help bridge the gap between theory and practice -

A modal rank of 3 is hardly the ideal since theory and practice should be integrated as much as possible. It is encouraging to note, however, that apart from about 12% of the respondents, the rest agree that this aim is achieved satisfactorily to a large and very large extent.

PROVISION OF APPARATUS FOR SPECIFIC EXPERIMENTS:

A list of experiments suggested for the new syllabuses in Physics and Physical Science were rated according to whether:

- 1 - No. apparatus was available
- 2 - enough apparatus for demonstration
- 3 - enough apparatus for groups of upto 4 pupils
- 4 - enough apparatus for pupils to work in pairs
- 5 - enough apparatus for pupils to work individually

Analysis of the ratings for the experiments (a) to (o) as given in Appendix D P5 gave the following results.

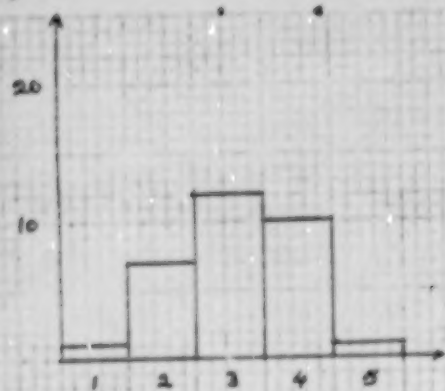
TABLE 22: RATING OF AVAILABILITY OF APPARATUS FOR EXPERIMENTS

Rating	Experiment and number of respondents														
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
1	1	7	2	1	2	9	7	11	7	2	0	16	0	16	16
2	7	17	20	2	7	16	23	13	22	25	6	17	1	14	14
3	12	4	5	11	14	5	1	4	2	2	10	0	14	1	0
4	10	1	4	10	3	1	1	1	0	1	11	1	11	1	0
5	1	0	1	7	4	0	0	2	0	0	4	0	6	0	0

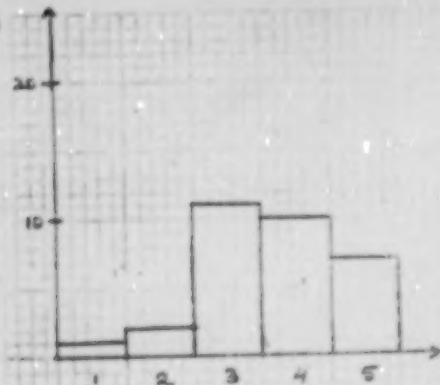
From the corresponding histograms Fig.4 (a) to (o) it can be seen that the

FIGURE 4: PROVISION OF APPARATUS FOR SPECIFIC EXPERIMENTS

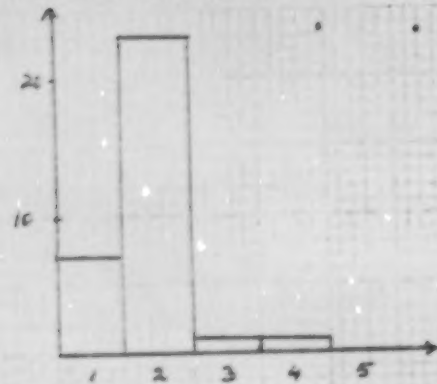
(a)



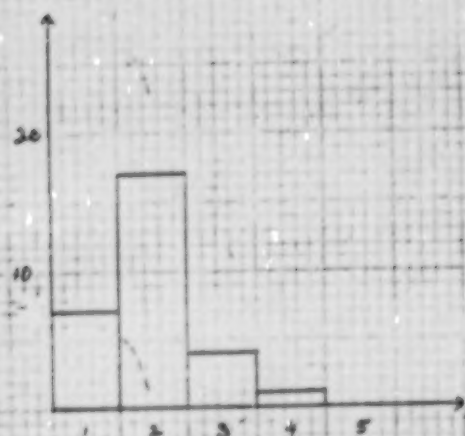
(d)



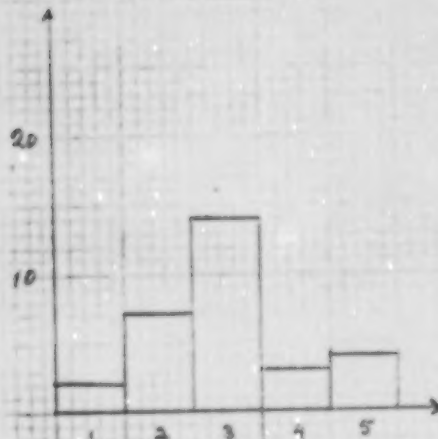
(g)



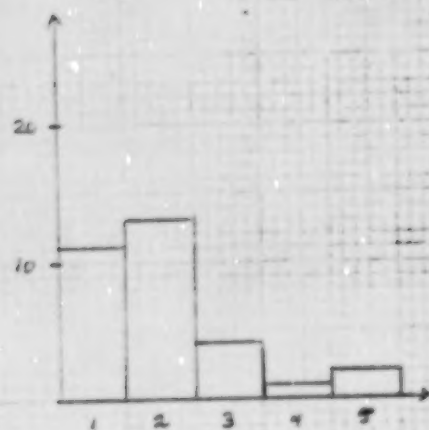
(b)



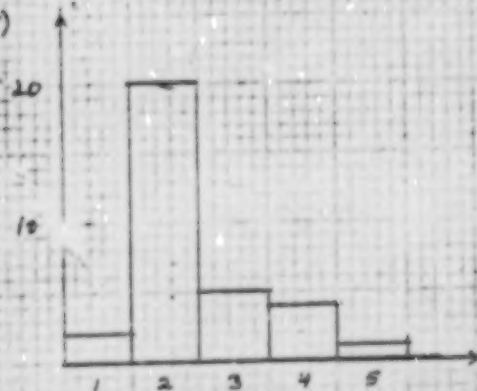
(e)



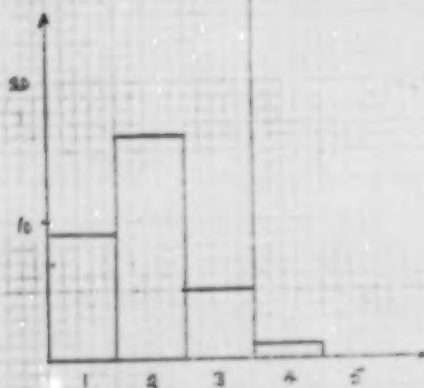
(h)



(c)



(f)



(i)

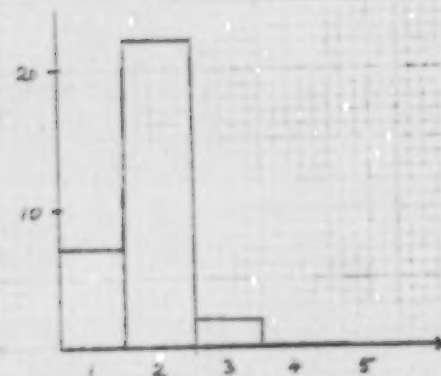
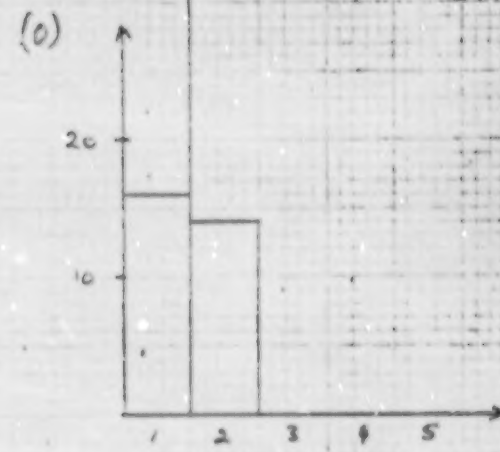
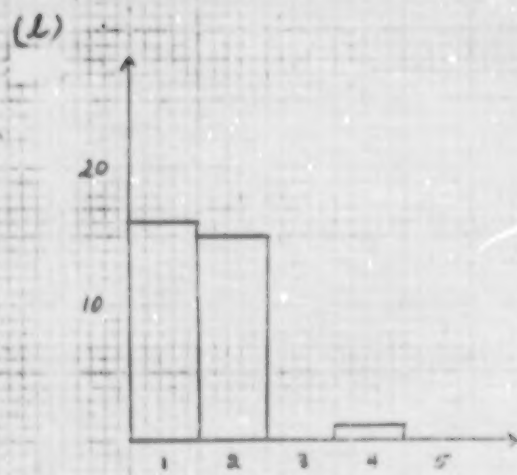
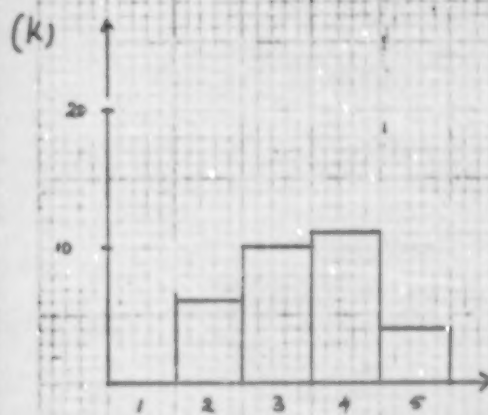
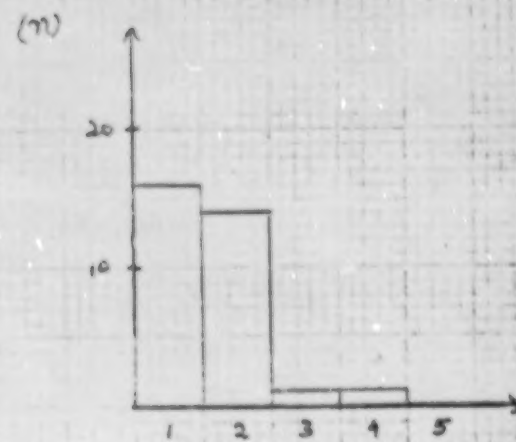
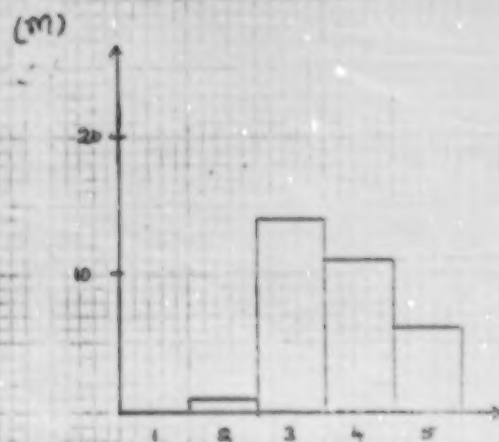
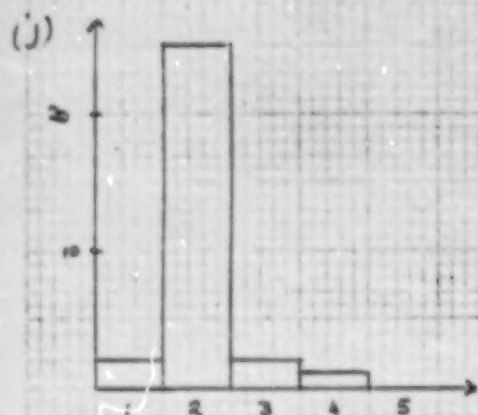


FIGURE 4 Contd.



selected experiments fall in three distinct categories:

Category I: This category is composed of experiments;

- (a) - Measurements of forces by a spring balance
- (d) - Image formation by diverging and converging lenses
- (e) - Experiments with magnets
- (k) - Circuit board experiments
- (m) - refraction of light by glass prism and visible light spectrum

This category of experiments seem to have their modes around 3 and 4 showing that many of the schools have enough equipment for groups ranging from 2 to 4 pupils per group.

Category II: Composed of experiments;

- (b) - demonstration of transmission of pressure using the pressure box
- (c) - convection currents in air and liquids
- (f) - Ticker tape time for measurement of velocity and acceleration
- (g) - energy converters such as a motor or flywheel
- (h) - estimation of the approximate size of a molecule
- (i) - demonstration of the faslaws
- (j) - to distinguish between longitudinal and transverse waves

Most of these experiments seem to have enough equipment just for demonstration by the teacher only. This would mean that at the most many schools have at least one set of apparatus. One anomaly, however, in this category is the high incidence of a rating of no apparatus for (h). This is definitely one example where standard equipment is not essential and any big trough and source of dust like chalk dust.

Category III - This is composed of experiments;

- (l) - simple vacuum diode characteristics
- (n) - Photoelectric effect
- (o) - Radioactivity

The modal ratings for this three experiments indicate that more schools than not, do not have any apparatus for demonstrating these concepts.

Those schools that do, have only in sufficient quantity to facilitate only demonstration experiments.

It will be worth noting at this juncture to point out the results give useful pointers to the availability of apparatus in our schools.

(iii) ANALYSIS OF THE OBSERVATION SCHEDULE

(APPENDIX E)

As mentioned earlier, the observation schedule was used in 17 of the 21 schools. Almost the same number of boys' and girls' schools were observed as shown by table 23.

TABLE 23: A SUMMARY OF SCHOOLS OBSERVED AND THE SUBJECTS OFFERED/OBSERVED

SCHOOLS	PURE PHYSICS	PHYSICAL SCIENCE	GENERAL SCIENCE	TOTAL
BOYS	4	2	0	6
GIRLS	4	0	2	6
MIXED	2	0	3	5
TOTAL	10	2	5	17

In many schools the class presented for observation was a pure Physics class especially where both Pure Physics and Physical Science was being offered to different classes. Observations were carried out in form III in all the schools.

The tallying procedure of 20 tallies per minute was adhered to, throughout all the observations. For a given lesson, a specific number of tallies was made for each interaction. To determine the frequency of occurrence for a given interaction, the number of tallies for that interaction was computed as a percentage of the total number of tallies for all the interactions in the lesson. For instance, if 100 tallies were entered for students working with apparatus, out of a total of 500 tallies for the lesson, then 100/500 or 20% of the time was spent by students working with

with apparatus. Where more than one interaction was taking place, then each interaction was tallied independent of the other.

The mean percentage of the observed interactions was then computed for similar lessons in the same Physics course, thus separately for Pure Physics, Physical Science and General Science Physics.

Out of a total of 10 Pure Physics lessons observed only one was a 40 - minute lesson used to revise some problems that had been previously set. A second revision lesson was part of an 80 - minute revision and demonstration lesson. All the General Science lessons were 40 - minute lessons and these were taught mainly in the classroom with the exception of one or two cases.

TABLE 24: A SUMMARY OF THE DURATION OF OBSERVED LESSONS

LESSON	80 MIN	40-MIN	TOTAL
Pure Physics	9	1	10
Physical Science	2	0	2
General Science	0	5	5
TOTAL	11	6	17

The classes observed ranged from 45 pupils to 18 pupils per class in Physics Pure, 39 to 29 pupils for Physical Science and 33 to 26 for General Science.

TABLE 25: THE MEAN CLASS SIZES OBSERVED

SUBJECT	MEAN SIZE	LARGEST	SMALLEST
Pure Physics	31.4	45	18
Physical Science	34	39	29
General Science	29.2	33	26

The mean class size in table 25 was computed from all the

observed values.

Compared to the average class size of 36.9 for the whole school it can be seen that the Physics classes are usually small.

Most of the work in the lessons was organized in groups of 5 or less pupils. However, none of the apparatus had apparatus enough for one set per student. The smallest group size was 2 - 3 pupils per group but many were 3 - 4 pupils per group.

Out of a total number of 17 observations done 7 were class experiments, 3 were teacher demonstrations and 7 were lectures or revision lessons.

TABLE 26: THE PERCENTAGE MEAN OF OBSERVED INTERACTIONS

INTERACTIONS IN PURE PHYSICS LESSONS												
INTERACTIONS/ OBSERVATIONS	1	2	3	4	5	6	7	8	9	10	11	12
a	23.4	6.7	0	0	5.0	4.2	30.3	11.8	0	13.4	0	5.0
b	33.3	18.8	0	29.2	0	12.5	0	6.3	0	0	0	0
c	41.2	9.3	0	8.0	0	9.3	0	22.7	9.3	0	0	0
d	26.3	10.7	0	0	8.3	1.9	34.1	12.7	3.9	2.2	0	0
e	1.2	0	0	0	10.4	4.6	50.9	23.1	0	9.8	0	0
f	40.6	16.4	0	19.3	0	12.3	0	3.6	0	0	2.9	0
g	7.3	0	0	7.3	11.7	2.9	46.9	7.3	5.8	3.3	0	7.3
h	12.2	1.4	1.4	2.0	15.9	0	46.1	6.8	0	5.4	0	7.8
*i	21.3	21.7	0	0	0	4.5	0	12.7	30.3	0	0	9.5
*j	16.2	35.1	0	2.7	0	33.1	0	4.7	0	0	0	8.1
MEAN I	23.2	5.8	0.2	8.2	6.4	6.0	26.0	11.8	2.4	4.4	4	2.5
MEAN II**	18.8	28.4	0	1.4	0	18.8	0	8.7	15.2	0	0	8.8

* - Observations made during revision lessons

** - Mean II is for (i) and (j) only

Mean I in table 26 was calculated omitting (i) and (j) the revision lessons, whereas mean II is for only (i) and (j).

FIGURE 5

The Percentage mean of observed interactions in
Pure Physics lessons

(excluding the observations from revision
lessons)

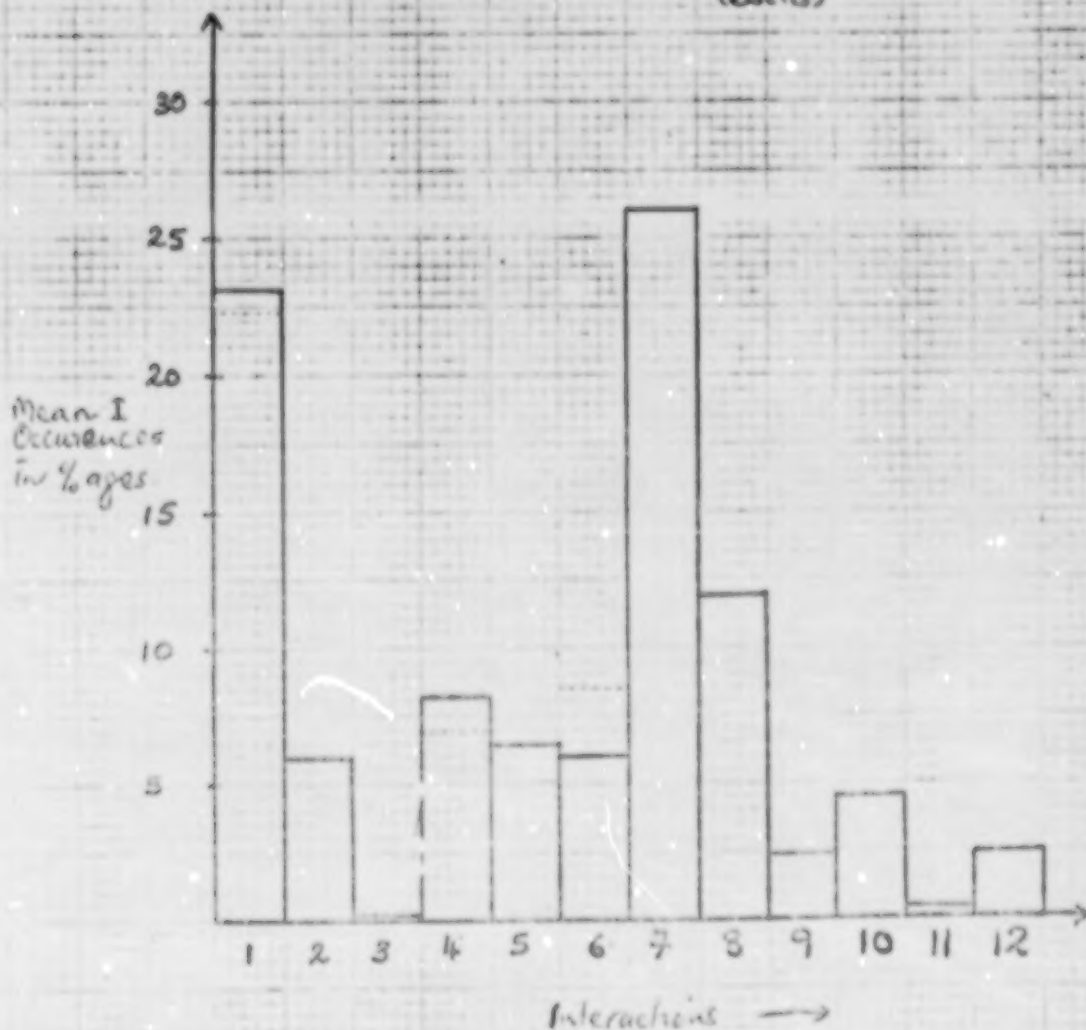


Table 26 shows that for observations (a) to (h) the predominant interactions are 1 and 7. Incidentally interaction 1 is 'teacher lectures pupils' and interaction 7 is 'pupils follow instructions in working apparatus'. Taken together these interactions account for slightly less than 50% of the total time in the laboratory. Figure 5 show these percentage means showing modes at 1 and 7.

Similar tables to table 26 were made up for Physical Science and General Science shown in tables 27, and 28 respectively. From table 27, figures 6 was drawn to compare the observed interactions in General Science and mean 11 from table 26 for the revision lessons in Pure Physics.

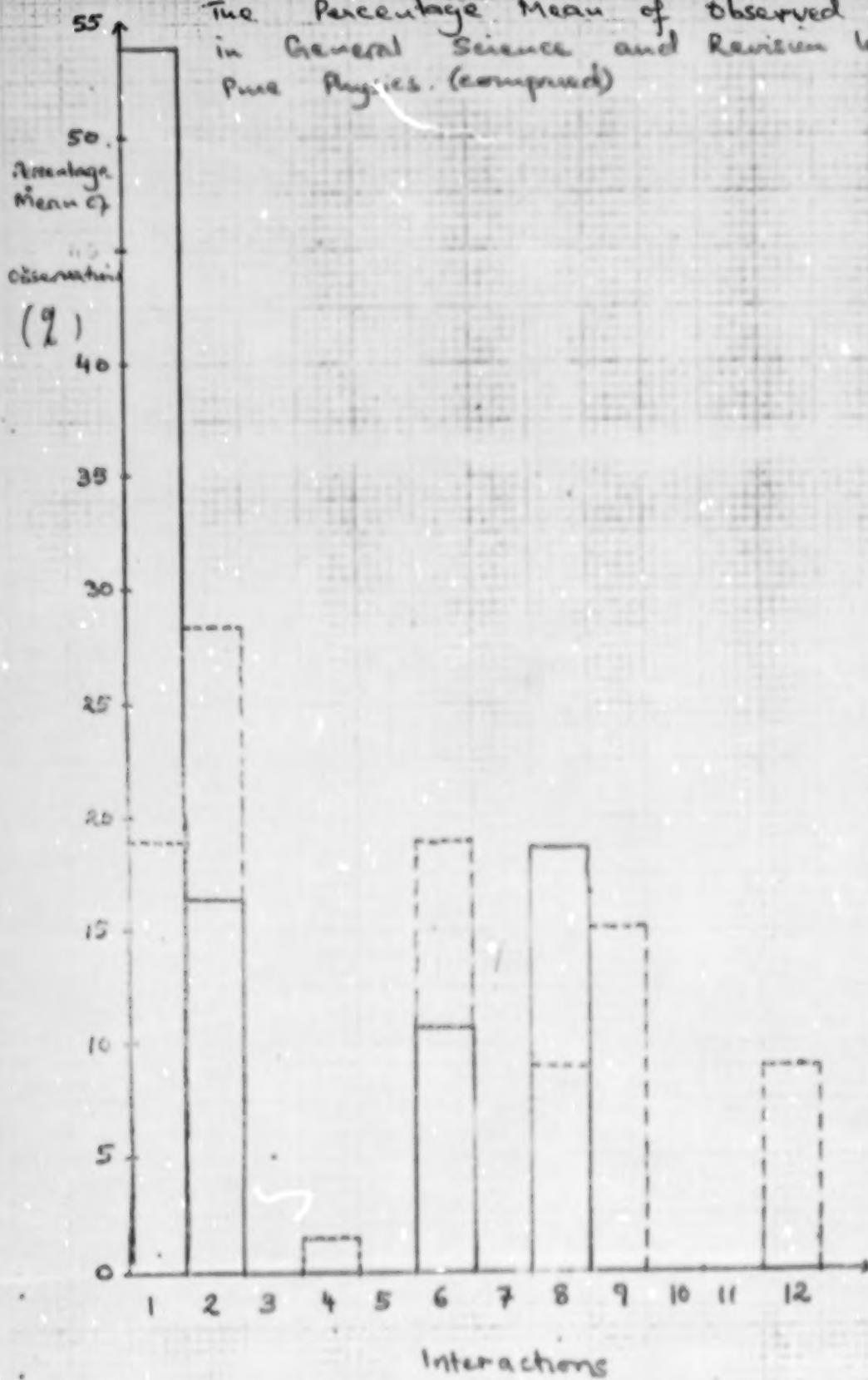
TABLE 27: THE PERCENTAGE MEAN OF OBSERVED INTERACTIONS IN PHYSICAL SCIENCE PHYSICS LESSONS

PHYSICAL SCIENCE	1	2	3	4	5	6	7	8	9	10	11	12
a	8.4	.9	0	5.6	9.8	.9	37.2	35.3	0	1.9	0	0
b	3.6	0.1	0	0	32.8	.1	45.1	15.4	0	0	0	.1
c												
MEAN %	6	.5	0	2.8	21.3	.5	41.2	25.4	0	.9	0	.05

TABLE 28: THE PERCENTAGE MEAN OF OBSERVED INTERACTIONS IN GENERAL SCIENCE

GENERAL SCIENCE	1	2	3	4	5	6	7	8	9	10	11	12
a	50	27.3	0	0	0	13.6	0	9.1	0	0	0	0
b	74.2	16.1	0	0	0	9.7	0	0	0	0	0	0
c	37.4	7.0	0	0	0	8.8	0	46.8	0	0	0	0
MEAN %	53.9	16.8	0	0	0	10.7	0	18.6	0	0	0	0

The Percentage Mean of observed interactions
in General Science and Revision lessons in
Pure Physics. (compared)



DISCUSSION

LECTURE:

This interaction has the highest observed mean of 53.9% in general science and a low mean of 6% in Physical Science. Even compared to the revision lessons in Pure Physics where the mean is 18.8% the general science mean is still too large. The rather sizable mean in the Pure Physics practical lessons is acquired from either giving instructions prior to the pupils working with the apparatus or from explanations prior to demonstrative experiments. Out of the three to four interactions in the General Science lessons the lecture accounts for more than half of the time used in the lessons.

TABLE 29: A COMPARISON OF THE USE OF LECTURES IN DIFFERENT LESSONS

LESSON	PERCENTAGE MEAN %
General Science	53.9
Pure Physics (Practicals)	23.2
Pure Physics (Revision)	18.8
Physical Science	6.0

2. TEACHER ASKS/ANSWERS QUESTIONS AND ACKNOWLEDGES PUPILS ANSWERS

This accounts for 28.4% of the interactions in the revision lessons and 16.8% in the General Science lessons. Apparently this interaction is minimal in the practical lessons in Pure Physics and Physical Science Physics with means of 5.8% and 0.5% respectively.

3. STUDENTS ASKED TO DESIGN THEIR OWN EXPERIMENTS

In many cases the experiments are selected by the teacher and other than say being asked to connect up a circuit in cases where it is not drawn, students never get the opportunity to design any experiments. Probably this is because of the cookbook approach with which Physics experiments are done.

4. TEACHER DEMONSTRATES

Teacher demonstrations were used in two instances during the observations. In one case the teacher used a short demonstration to introduce the class experiment as well instruct them on the type of readings they should take. In the second instance demonstration lessons were used where only one

set of apparatus was available to the teacher. In this last instance the demonstrations took upto a maximum of 29.2% of the lesson time to a minimum of 2.0% of the lesson time.

Of notable exception is the complete absence of demonstration lessons in the general science lessons. It would be the next best approach as opposed to the lecture method so preferred.

5. TEACHER ASSISTS PUPILS IN WORKING WITH APPARATUS

This interaction scores a very small mean of only 6.4% in Pure Physics practicals and 0% in General Science. There is a general tendency to let the pupils to work entirely on their own especially where the instructions are written on the chalkboard or in the form of a laboratory guide. It is, however, gratifying to note that in cases where instructions are explicit the teacher can do little else.

6. PUPILS ASK AND ANSWER QUESTIONS

This interaction also scores a very low mean in the practical lessons. It, however, scores a notable mean of over 10% in the General Science lessons. This should be expected since there is need for this interaction.

7. PUPILS FOLLOW THE STEP BY STEP INSTRUCTIONS IN THE LABORATORY GUIDE

This was taken to include pupils working with apparatus using instructions either from the chalkboard or a guide. This was the predominant activity in the practical lessons. Although it shows a modest mean at 26% wherever this activity was recorded it was very predominant. It is a pity that the demonstration lessons were noted to be completely lacking in this interaction. It would have been worthwhile involving pupils in the demonstration experiments.

8. PUPILS RECORD INFORMATION REQUESTED BY THE TEACHER OR LABORATORY GUIDE

As mentioned earlier this is an interaction that in many instances should have taken place simultaneously as interaction 7. Surprisingly, in many

of the practicals observed this interaction followed immediately after 7.

9. PUPILS SOLVE PROBLEMS

This interaction was minimal in the practical lessons although it features predominantly in the Physics theory lessons. There is no justification for its complete absence in the General Science lessons.

10. PUPILS DISCUSS THEIR DATA AND CONCLUSIONS WITH EACH OTHER

Although this interaction was very prevalent during interaction 8 it was inhibited by the insistence of some teachers on individual work. One tends to ask whether it is possible to write a truly individual report after the experiment has been carried out in a group of say 5 pupils or less.

11. LABORATORY USED TO INVESTIGATE PROBLEMS THAT ARISE IN CLASS

It was quite evident that every laboratory exercise was planned well in advance by the teacher and sometimes to the exclusion of what else was going on in the sequence of the teaching of the particular Physics Course. Only one incident was recorded in which a pupil's question triggered off a demonstration that apparently the teacher had not planned. The demonstration was used to illustrate an answer to the pupil's question.

12. NOISE/CONFUSION

Time spent in this state was due mainly to distribution of apparatus and during clean-up before the end of the lesson

NOTABLE OMISSIONS IN THE LESSONS

A lot of the lessons observed seemed to lack the sequencing that is so often stressed during the training of teachers. Teachers are usually

advised to divide their practical lessons into;

- . introduction or resume' of previous lesson
- . instructions and methodology
- . experiment under teacher supervision
- . analysis and discussion of group results
- . conclusions

Many of the practicals carried out were just mainly a set of instructions written or dictated out and copied. No discussion of results or conclusions was ever held in any of the lessons. Is it possible that many of the do's and don't's of teacher training are impossible to attain in the classroom? Or is it because a large number of the Physics teachers have not been actually trained to be teachers. It can be seen that of the teachers who responded to Appendix D, about 43% are untrained, thus including holders of general degrees and A-level school leavers.

CHAPTER FOUR

FINDINGS AND CONCLUSIONS

1: THE EXTENT OF AVAILABILITY OF LABORATORIES

50% of the Government Schools have two Physics laboratories one for A-level Physics and another for O-level Physics. About 38% of the private schools have only one laboratory for all the three science subjects. Many of the Government Schools have two laboratories for the three science subjects.

Most of the Government Schools have enough laboratories to enable them to do most of their teaching in the laboratory. This is not the case with many of the private schools that offer General Science, because the number of classes in such schools are too many for one laboratory to be shared between three science subjects.

As discussed earlier on page 27, 30.3% of the Physics teachers have access 30.4% of all the available laboratories for O-level Physics only while 37.1% have access to 37% of the laboratories for both O-and

A-level Physics. With the available number of laboratories 37.1% of the teachers reported a laboratory use of upto 2 lessons per week whereas only a meagre 11.4% use their laboratories for all their Physics teaching. Even then the amount of time devoted to lectures and theory lessons accounts for about 45.2% of the total time in the year, (see table 18) as compared to class experiments.

2: THE QUALITY OF LABORATORIES

(a) EQUIPMENT

Many of the respondents agreed that their laboratories were fairly well equipped. However, from table 22 it can be seen that for certain specific experiments the apparatus is either completely lacking and in a majority of experiments there are just enough apparatus for demonstration experiments as the modes indicate. This means that if a majority of the experiments have no apparatus or just enough for demonstration experiments, then the pupils do not get sufficient practice with the apparatus.

(b) THE COST OF EQUIPPING A LABORATORY

The Ministry of Education has set initial equipment grants for developing schools. These grants for science classes are allocated as initial Science Equipment Grant for new classes for the first stream and it is K£400 for form I and K£300 for form III. In cases of A-level Science classes the amounts allocated are K£2,000 each for forms V and VI, and this includes the buying of textbooks.

Compared to other subject grants of K£80 per class for forms I to IV and K£500 for forms V and VI arts it can be seen that it is indeed expensive to run science classes.

The cost of buying equipment for the laboratory falls squarely on the school, which is supported by fees paid and annual grants from the Ministry of Higher Education. As mentioned earlier about 64.3% of the schools put their expenditure at over Kshs.3,000 over the past two to three years. The majority of this group are Government Schools, but there are still some Government Schools who put their expenditure at less than Kshs.3,000.00.

In the case of private schools, a few of them put their expenditure at more than Kshs.3,000.00 for the past few years. Many of the private schools raise their equipment money either from fees, a sort of special equipment levy for science classes, while some community aided schools raise this money from donations by members of the community. In cases of community schools the expenditure was usually put at higher than Kshs.3,000.00 due to these donations.

Considering the cost of Science kits (ref. table 3), Kshs.3,000.00 cannot buy upto three sets of Physics, kits at the most. This means that schools that put their expenditure at Kshs.3,000.00 or less must surely have bought very little over the past two to three years. Is it perhaps that science equipment is too expensive for schools? If so what ways are open to ease this high expenditure?

(c) THE PURCHASING OF EQUIPMENT

A significant 50% of the schools buy their equipment near examination time. Surprisingly these are the same schools that prepare their candidates for the practical examinations at the end of form IV. It is obvious that materials bought near examinations time is basically for examination purposes. This means that in the real sense few or no equipment is bought for actual teaching during the year. This then defeats the purpose of preparing students for the practical examinations. Only 35% of the schools buy their equipment at the beginning of the year.

3. THE QUANTITY OF LABORATORY WORK DONE IN THE LABORATORIES

Given the total number of laboratory time in tables 12(a) and (b), most Government Schools have sufficient time to do all their Physics teaching in the laboratory. It is, however, evident that this is not the

the case instead the teachers agree that out of the total time available only 33.5% is spent on class experiments and 19.3% on demonstration experiments, compared to lectures/theory which account for 45.2% of the time. (see table 18). This reduces the role of the laboratory to that of an ordinary classroom where lectures and theory are conducted.

4. QUALITY OF LABORATORY WORK DONE IN THE LABORATORIES

(a) ACHIEVEMENT OF OBJECTIVES FOR PRACTICAL WORKS

For most of the aims suggested the teachers in the sample ranked them a modest satisfactory achievement. Many of the teachers agreed to achievement of the aims to a satisfactory extent tending to a large extent (see table 21 and Figures 3 (a) to (k). There are still some aims such as to train students in simple aspects of experimental design, which apparently a large number of teachers agree that they are only achieved only to a small extent.

(b) INDIVIDUAL VERSUS GROUP WORK OR TEACHER CENTRED WORK

As mentioned earlier 19.3% of the time in the laboratory is spent on demonstration experiments and 33.5% on class experiments. The teachers agree that for most experiments they have enough apparatus for demonstration by the teacher only (see table 22 and figures 4b, c, f, g, h, i and j). For those experiments where there are enough apparatus for class experiments, most are such that the apparatus is sufficient for groups of upto 3 to 4 pupils and sometimes upto 5 pupils per group.

It can be seen that individual practical work is almost impossible and demonstration and teacher centred work more prevalent than groupwork. It was observed that in cases where demonstration experiments were used pupil participation was minimal.

5. EFFECT OF LABORATORIES ON PERFORMANCE AT THE O-LEVEL EXAMINATIONS.

The Kenya Certificate Examination¹ report points out obvious shortfalls in practical skills in the practical examinations. Incidentally schools that offer Physics Pure especially the new syllabus are selected according to the facilities that they have. This enables maximum utilizing of these facilities to prepare for the practical as well as the theory examinations. Even the pass rates as shown by table 13, show that maybe similar emphasis on availability of facilities for both Physical Science and General Science, should be made in order to raise their pass rates. Surely the pass rate in Pure Physics can be higher than 42 - 43% as given in table 13.

CONCLUSION

Since the laboratories do infact exist especially in Government Schools, then these are not sufficiently^{USE IT} for the teaching of Physics for reasons that have been discussed, of apparatus and to a certain extent their use by teachers. There is need for having well qualified teachers, to teach the subject. This problem has been overlooked by employing BSc and other general degree holders who have no training in Education. This is a nationwide problem since for about 2,000 secondary schools all over the republic about 1,000 Physics teachers are so far employed. The annual output of Physics teachers is just about 100 teachers and usually when posted in schools many of these teachers prefer to teach their second subject such as Maths or Chemistry or Industrial Education. As an incentive entry requirements for training of Physics teachers have been set at minimum, but even then very few opt for the subject.

It is also imperative to note that in view of the availability of the laboratories, efforts should be made to standardise the distribution of science equipment to schools.

Maximum use of the laboratories should be made by the teachers and they should be encouraged to use improvised apparatus. It is also probably not enough to just encourage teachers, but it would be better to train teachers in the use of improvised apparatus. As seen in the response to the experiment of finding the approximate size of a molecule, it is evident that many teachers do not realise that such an experiment has no standard equipment. Such a state of affairs could be attributed to the type of or lack of training of the teachers or else on the type of textbooks that are used as class texts. It would help a lot if for every course developed, a suitable text was developed that is relevant to the course, the environment and learners. In accordance to what has been shown by the findings of this study, the teaching of Physics in Kenyan Schools leaves a lot to be desired. There is need to consolidate the measures that have already been taken to improve Physics teaching by providing enough laboratories, equipment, trained teachers and qualified support personnel. It is also worth noting that other than making the above provisions, supervision should be stepped up to ensure that Physics is well taught in our schools. Since national examinations are set for all schools in Kenya, then the above measures would ensure that every learner gets an equal opportunity for further education or for job selection.

In summary some of the steps to be taken would include;

- (a) to ensure the availability of a laboratory for Physics for every school whether private or government and regardless of the Physics course being taught.
- (b) to set a minimal quantity of laboratory equipment that every school should have depending on the school population.
- (c) to ensure a fair distribution of qualified Physics teachers in the country and the organization of a training programme, inservice or otherwise, for teachers of Physics. This is in view of the fact that a large number of Physics teachers are not trained teachers.

- . (d) to make it an obligation of the Ministry of Higher education to hire and pay laboratory assistants and technicians for every school. At present this is done by the school board of governors and it is not being done satisfactorily due to lack of funds.
- . (e) to ensure that as need arises, for every syllabus change, necessary support material should be prepared to effect the changes, so that teachers know how to handle the changes. This would also include the importance that the laboratory has in effecting the intended changes.

REFERENCE MATTER:

A Appendices

- | | | | |
|----------|---|---|--|
| Appendix | A | - | Interview schedule with the Inspector of schools for Physics |
| Appendix | B | - | Interview schedule with the Provincial Education Officer - Nairobi |
| Appendix | C | - | Questionnaire for Head teachers |
| Appendix | D | - | Questionnaire for Physics teachers |
| Appendix | E | - | Observation schedule for
Physics laboratories based on
Appendix F |
| Appendix | F | - | A description of the laboratory
Programmes variables Inventory (LPVI) |

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APPENDIX A

INTERVIEW SCHEDULE WITH THE SENIOR INSPECTOR OF SCHOOLS FOR PHYSICS

Date.....

A: BACKGROUND

1. Types of secondary schools and criteria for classification.....
2. Why is it that more than one Physics course is offered at O-level?
.....

LABORATORIES AND THEIR DISTRIBUTION

3. What are the MOW specification for a laboratory?

Is a science laboratory the same as a science room?
(Curriculum Guide for Secondary Schools).
4. Who is responsible for building and equipping science laboratories?
.....
.....
5. a) What is the role of SEPU?
.....
b) Are SEPU prices controlled for school purchases?.....
c) What are the future plans by the ministry as regards production of laboratory equipment at SEPU rather than importing them?.....
.....
.....

C: STAFFING

6. How serious is the shortage of Physics teachers in terms of actual numbers employed, output the colleges and drain into the private sector?

.....

a) Numbers employed: =

Shortfall =

b) Output =

c) Drain =

7. What efforts are being made to produce enough qualified teachers?

.....

.....

- 8.a) Who employs laboratory assistants or

technicians?.....

- b) In the absence of such a person the teacher usually does the work of preparing for practical lessons. What incentives does the teacher get?

.....

.....

9. In many cases Physics is considered as a very expensive subject by administrators and a very difficult subject by learners. Examination results tend to support this view. What efforts are being made to make Physics cheaper and less difficult to the learners? So as to improve the examination results?

Cheaper:.....

Less difficult:.....

...../3

- b) Of particular note is the fact that practical examinations tend to show a lot of deficiencies in the teaching of Physics. What steps are taken to remedy these deficiencies?

.....
.....

10. The new O-level syllabuses have merged the SSP syllabus and the traditional Physics syllabus. Do we have an adequate number of well equipped school laboratories with well trained teachers to effectively implement the amount of practical work required?

APPENDIX B

INTERVIEW SCHEDULE WITH THE PROVINCIAL EDUCATION OFFICER NAIROBI

1. (a) How many secondary schools are there in Nairobi?
- (b) Of these schools, how many are government and how many are private?
- (c) Is it possible to supply a list showing the grading of the schools?
- (d) How many are boarding and how many are day?
- (e) Which of the schools have A-level Physics as well as O-level Physics? (or which Physics Courses do these schools offer).
2. What is the performance of the above schools in the O-level Physics examinations like?

(A summary of the overall performances)

APPENDIX C

QUESTIONNAIRE FOR HEAD TEACHERS

1. Name of school _____
2. Indicate whether your school is government or private?

	GRADE
Government Maintained	
Government Assisted	
Unaided Community	
Private	
Other (specify)	

3. a) What is the total number of classes in your school?
 b) How many streams are there in Forms I to IV?

 c) What is the average size of your classes?

 d) What is the total school population?

4. Indicate the Physics courses that you offer in your school and how many pupils are involved in each course.

Course	Number of Classes/ streams	Total number of pupils -
i) A-level Physics		
ii) Pure physics (separate subject)		
iii) Physical Science Physics		
iv) General Science Physics		

5. a) How many Physics teachers do you have? _____

b) What are their qualifications?

<u>QUALIFICATIONS</u>		<u>NUMBER</u>
i)	Untrained A-level	
ii)	SI	
iii)	Approved teacher	
iv)	Diploma in Science Education	
v)	BSc. general	
vi)	BSc. with Education	
vii)	BEd (Science)	
viii)	Other	

Specify for (viii) _____

6. How many Physics laboratories does your school have? _____

- a) One for Physics (O-level) only
- b) One for both O-and A-level Physics
- c) One for both Physics and Chemistry/Biology
- d) One for Physics/Biology and Chemistry
- e) None
- f) Other _____

i) Specify for (f) _____

ii) where is Physics taught in your school
if your answer is (e)?

7. a) Do you laboratories have the following facilities?
(Answer Yes/No)

- i) Water _____
- ii) Electricity _____
- iii) Store room _____
- iv) Gas _____

b) In your opinion are the laboratories well equipped? _____ (Yes/No)

8. a) Estimate the expenditure, say over the last two to three years, in equipping the laboratories.

- i) Less than Ksh. 3,000.00
- ii) About Ksh. 3,000.00
- iii) More than Ksh. 3,000.00

b) When are the major purchases for the laboratories done?

- i) At the beginning of the year
- ii) As they arise during the year
- iii) Near examination time
- iv) Other time

Specify for (iv) _____

9. a) What would you say about the performance of your students in Physics in the O-level examinations over the last three years?

- i) Very good
- ii) Good
- iii) Satisfactory
- iv) Poor
- v) Very poor

b) What factors may have contributed to the performance?

10. In your opinion, what improvements would you like to see done in the use of the laboratory for teaching Physics? _____

APPENDIX D

QUESTIONNAIRE FOR PHYSICS TEACHERS

A. BACKGROUND INFORMATION

1. Name of School _____
2. Name of teacher (optional) _____
3. What is your professional qualification?

- | | | |
|----|---------------------------------------|--------------------------|
| a) | Untrained teacher (A-level) — — — — — | ☐ |
| b) | P1 — — — — — | ☐ |
| c) | S1 — — — — — | ☐ |
| d) | Approved teacher — — — — — | ☐ |
| e) | BSc. (general) — — — — — | ☐ |
| f) | BSc. with Education — — — — — | ☐ |
| g) | BEd (science) — — — — — | ☐ |
| h) | Other — — — — — | ☐ |

Specify for (h) _____

4. Which Physics courses do you teach?

- a) A - level Physics
- b) Pure Physics
- Physical Science Physics
- General Science Physics.

5. For how many years have you taught Physics? _____

6. What is your major teaching subject?

7. What is your second teaching subject?

8. How many classes do you teach Physics? _____

9. What is your weekly teaching load? _____
_____ lessons.

B. QUANTITY AND QUALITY OF LABORATORIES
AND LABORATORY WORK

10. How many Physics laboratories does your school have? _____

- a) One for Physics (O-level) only _____ ☐
- b) One for both O- and A-level Physics _____ ☐
- c) One for both Physics and Chemistry/Biology _____ ☐
- d) One for both Physics, Chemistry and Biology _____ ☐
- e) None _____ ☐

Specify where you teach your Physics classes if your response is (e) _____

11. How often do you use the laboratory for teaching each of your Physics classes?

- a) Three lessons per week _____ ☐
- b) Two lessons per week _____ ☐
- c) One lesson per week _____ ☐
- d) Two lessons every alternate week _____ ☐
- e) Other arrangements _____ ☐

Specify for (e) _____

12. How much of the time in the laboratory do you devote to the following aspects for any one of your classes?

	Number of lessons per year
a) Class experiments	_____
b) Demonstration experiments	_____
c) Lectures/theory	_____
d) Other	_____

Specify for (d) _____

13. In your laboratory, rate the adequacy of the following provisions; (indicate by a tick)

	Adequate	Not adequate	Not available
a) Benches			
b) Stools/chairs			
c) Apparatus			
d) Water			
e) Electricity			
f) Storage			

14. a) What is the average size of groups for your class experiments?
(Tick where appropriate)

Pupils per group	
1 to 2	
2 to 3	
3 to 4	
More than 4 but less than 6	
Upto 10	

- b) What is the average number of pupils per class?
-

15. The following are some of the laboratory aims for Physics practicals. To what extent would you say these are achieved in your laboratory lessons? Indicate your responses by ranking them according to the following specifications and ticking in the appropriate column.

.... /4

Rank order	Response	Rank Order
1	Not at all	1
2	To a small extent	2
3	To a satisfactory extent	3
4	To a large extent	4
5	To a very large extent	5

AIMS	RANKS				
	1	2	3	4	5
a) To teach basic practical skills					
b) To familiarize students with standard apparatus & measurement techniques.					
c) To train students in making observations					
d) To train students in making deductions from measurements and interpretations of experimental data.					
e) To use experimental data to solve specific problems.					
f) To train students in writing reports on experiments.					
g) To train students in simple aspects of experimental design					
h) To arouse and maintain student interest in the subject.					
i) To show the use of practicals as a process of discovery					
j) To verify scientific facts					
k) To help bridge the gap between theory and Practice					

16. Give an estimate of the expenditure in the Physics laboratory over the past two years. (Tick where appropriate)
- No expenditure at all
- Expenditure upto sh 3,000.00
- Expenditure more than sh 3,000.00
- Not sure about the expenditure

17. a) Do you have a laboratory technician or a laboratory assistant?

- b) How many laboratories does the technician/assistant serve? _____

* A laboratory assistant is not necessarily trained. He assists in the washing up and general cleaning in the laboratory).

18. The following are experiments suggested in the new 0-level physics syllabuses and the suggested scheme of work. How well equipped is your laboratory to effect the teaching of the concepts using the experiments. Use the following table to indicate your responses.

Rank	Response	Rank
1	No apparatus	1
2	Enough apparatus for Demonstration	2
3	Enough apparatus for groups of upto 4 pupils	3
4	Enough apparatus for pupils to work in pairs	4
5	Enough apparatus for pupils to work individually	5

Experiment	1	2	3	4	5
a) Measurement of forces by a spring balance					
b) Demonstration of transmission of pressure using the pressure box.					
c) Convection currents in air and liquids					
d) Image formation by diverging and converging lenses.					
e) Experiments with magnets					
f) Tickertape timer for measurement of velocity and acceleration					
g) Energy converter such as a motor or flywheel.					
h) Estimation of approximate size of a molecule.					

	1	2	3	4	5
i) Demonstration of the gas laws					
j) To distinguish between longitudinal and transver waves.					
k) Circuit board experiments for measuring potential differences, current & resistances					
l) Simple vacuum diode characteristics					
m) Refraction of light by glass prisms and visible light spectrum.					
n) Photoelectirc effect					
o) Radioactivity					

19. a) What would you say about the performance of your students in Physics in the O-level examinations over the last three years?

Very good	
Good	
Satisfactory	
Poor	
Very poor	

- b) What factors have contributed significantly to the performance? _____

20. Comment on any of the points about the quality and quantity of laboratory work done in the school laboratory. (Use the space provided below)

APPENDIX E

OBSERVATION SCHEDULE FOR PHYSICS LABORATORIES

(Based on the Laboratory Programme variables Inventory¹
and Flanders' Interaction Analysis²)

A BACKGROUND

Date _____

1. Name of School _____
2. Class (Form) _____
3. Teacher's Name _____
4. Is the school for boys (B), girls (G) or mixed (M)

0	B	
1	G	
2	M	

(Tick the
appropriate one)

5. Duration lesson _____
6. Number of pupils in class _____
7. Number of sets of apparatus _____

8. Size of groups	1	2	3	4	More than 4

B. INTERACTIONS

- I - Teacher - pupil - all activities
that are initiated by the teacher. This will
include responses to pupils answers.
- II - Student - teacher - these activities will include
asking and answering questions and seeking directions.
- III - Student - materials & students
Working with apparatus
This will include working from manuals or
laboratory guides and recording of observations.
- IV - Student - student - discussions,
Working in groups and consultation.

- V - Silence and confusion in this case interaction is not observable.

NOTE:

The tallies are made at a rate of about 20 for every minute. This will be done for the first period in a double lesson-and for the first half hour in a 40-minute lesson.

INTERACTION	TALLIES	TOTAL
I 1) Teacher lectures the pupils as a class		
2) Teacher asks questions answers questions and acknowledges student response:		
3) Students asked to design their own experiments.		
4) Teacher demonstrates		
5) Teacher assists pupils in working with apparatus		
II 6) Pupils ask questions and answer questions		
III 7) Pupils follow the step by step instructions in the laboratory guide		
8) Pupils record information requested by the teacher or laboratory guide		
9) Pupils solve problems		
IV 10) Pupils discuss their data and conclusions with each other.		

		THREE'S	FOUR'S
11.	Laboratory is used to investigate problems that arise in class.		
V 12.	Noise/confusion		

C ORGANIZATION AND PROCEDURES

1. Were the instructions given orally, on the chalkboard or on a laboratory manual/guide?

Orally
Chalkboard
Laboratory guide

2. What type of lesson was this?

Lecture
Demonstration
Class experiment
Other

Specify _____

3. How well did the teacher accomplish the following tasks:

	Very Well	Satisfactorily	Not at all	Not observable
a) Give Instructions				
b) Involve pupils in discussions				
c) Answer Pupils' questions				
d) Motivate pupils				
e) Ask questions				
f) Achieve his objective				

Appendix F

The Laboratory Programme variables Inventory (LPVI)¹

This was originally developed as part of an attempt to define various laboratory forms operationally. It was used by students to describe the characteristics of the educational setting of a Science laboratory.

There were 25 items (characteristics) on the list, representing various aspects of the procedures, student-teacher and student-material interactions purposes and outcomes to which students might be exposed in their laboratory. The students were asked to rank these statements into five groups from most characteristic to least characteristic of their laboratory situation.

Some of these statements were adapted in the observation schedule, for assessing the laboratory classes in the sample schools. Instead of ranking the statements the Flanders interaction analysis was adopted by tallying against every statement at intervals of twenty tallies per minute. The number of tallies for every statement characterises the predominance of every interaction (see the observation schedule). It is possible that further studies can attempt to show correlations between the predominant interaction activities and the effectiveness of the laboratory teaching situation.

1. Michael R. Abraham: A descriptive Instrument for
Use in Investigating Science
Laboratories.

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2. Flanders, N: Analysing Teaching Behaviour 26 - 38